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ABSTRACT

Under-representation of minority students in science, mathematics, and related scholarly pursuits results in a significant portion of minority students unprepared to participate in science-related careers in adult life. Multicultural infusion offers an opportunity for science teacher educators to prepare a new generation of science teachers capable of meeting the needs of culturally diverse learners. Five components of programs that prepare teachers for multicultural classrooms are: (1) broad general education; (2) subject matter competency; (3) awareness of the needs of culturally diverse children; (4) content area pedagogical knowledge; and (5) field experiences working with culturally diverse learners. This approach produces culturally and ethnically literate teachers, incorporates the needs of culturally diverse learners into all aspects of science teacher preparation, and offers an opportunity for science teacher educators to prepare a new generation of science teachers. Existing education courses need to be restructured to address the needs of future teachers in multicultural classrooms by the use of a constructivist approach to teaching and learning, the incorporation of appropriate instructional strategies for culturally diverse learners, inclusion of relevant course content, introducing language acquisition skills, and a focus on social and cultural characteristics of diverse learners. (Contains 85 references.) (LL)

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Multicultural Infusion: A Strategy for Science Teacher Preparation

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National Association for Research in Science Teaching

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INTRODUCTION

Many culturally diverse students, especially those who speak a first language other than English, consistently perform less well on standard measures of academic achievement (e.g. SAT, GRE, MAT) than do their peers whose primary language is English (Schick & Schick, 1991). In addition, many suburban minority students achieve lower on tests of higher-order thinking skills than do their nonminority peers (Levine & Eubanks, 1990). Although high school drop-out rates at all socioeconomic levels are higher for culturally diverse students than for students of European descent, the high school graduation rate for African-American students has gradually improved since the passage of the 1965 Civil Rights Act. During the same time period, however, the high school graduation rate for Hispanic/Latino and certain Southeast-Asian students has actually declined (Schick & Schick, 1991). University participation rates among culturally diverse and low- income students provide good indicators of progress in educational equity. Historically, most culturally diverse students enroll in two-year community colleges rather than at four-year degree granting institutions (Carter & Wilson, 1991). In 1989, 23.5% of African-American high school graduates were enrolled in colleges and universities, compared with 16.1% of Hispanic/Latinos and 31.8% of whites (Digest of Educational Statistics, 1990). This trend toward community college enrollment by culturally diverse learners results in a situation in which the earning capacity of individuals is limited by their education.

Recent literature has attributed the under-representation of minority students in science fields to a variety of factors, such as: (a) lack of student interest in science (Berryman, 1983; Clark, 1986; Entwistle & Duckworth, 1977), (b) science anxiety (Clawson, Firment & Trower, 1981; Czerniak, & Chiarelott, 1985), (c) personality factors (Clark, 1986; Harlen, 1985), (d) white male dominated images of science (AAUW, 1992; Hill, Pettus, & Heddin, 1990; Kahle, 1985), (e) lack of minority role models in science and related technology careers (Sadker & Sadker, 1979; Powell, 1990), (f) socio-economic barriers (Patchen, 1982), (g) improper counseling regarding academic track coursework at the high school level (Marrett, 1981), (h) teacher attitudes and expectations (Karlin, Coffman, & Walter, 1969), and (i) lack of proper academic preparation (Harlen, 1985; Oakes, 1990). With these and possibly other factors contributing to the low participation by culturally diverse students in science, mathematics, and related scholary pursuits, the end result is that a significant portion of America's children are not being prepared to participate in science-related careers in adult life. We are rapidly becoming a nation of ethnic and racial "unmeltables" (Novak, 1971), a nation in which culturally diverse children are disenfranchised in science and related careers.

Ethnic Studies Approach

Traditionally, college and university teacher educators, including science teacher preparation faculty, have attempted to address the needs of culturally diverse learners by an ethnic studies approach (Givens, 1982). Such preparation typically includes content dealing with topics such as race relations or racial/ethnic sensitivity training for both preservice and inservice teachers. Garcia (1980) wrote that the race relations or sensitivity training approach "is based on the operational assumption that increased knowledge about an ethnic group can foster positive attitudes toward that ethnic group" (p. 116). Moreover, only teachers who planned to work in inner-city school systems or in other areas with large numbers of bilingual/bicultural students received such training. Ethnic studies courses typically include information about the heritage, language, foods, holidays, customs, beliefs, and attitudes of various racial and ethnic groups (Garcia, 1980). Advocates of the ethnic studies approach to teacher education maintain that teachers' awareness of the beliefs, attitudes, and values of other ethnic groups can eliminate ethnic bias, stereotyping behaviors, and racial discrimination in classroom interactions and dynamics (Garcia, 1980, p. 118).

While research indicates that the ethnic studies approach to teacher education does facilitate improved teachers' attitudes toward culturally diverse learners, there is no evidence that such an approach to teacher preparation results in improved instructional quality for or learning by these students. Indeed, the opposite may be the case. Gay (1983) pointed out that "educators have long operated on the belief that a teacher who could teach any student could teach all students" (p. 79). Gay further suggests that most teachers are "ethnically illiterate" and that their instructional strategies do not address the characteristics and needs of culturally diverse learners. In addition to the studies conducted by teacher educators, sociologist James Banks (1981) argues that an ethnic studies approach to preservice teacher education is not sufficient to bring about effective educational reform or equity.

Like teacher educators, Banks concludes that, while an ethnic studies approach does address teacher attitudes toward culturally diverse students, this approach does not confront multicultural instructional considerations, nor does it deal with preservice teachers' content area pedagogical knowledge or the need for field experience in a community similar to the one in which they will teach.

Multicultural Education and Diversity

Gilbert and Gay (1985) contend that "the means appropriate for teaching poor, urban Black students differ from those appropriate for teaching other students because teaching and learning are sociocultural processes that take place within given social systems" (p. 134). Without full consideration to the social and cultural aspects of learning, science educators teach preservice teachers such ideas as "meaning is constructed by each individual child", "knowledge is constructed within a socio-cultural context", and "learning occurs as the child struggles to make sense of their world". Tobin, Tippins, and Hook (1991) point out that "an individual is born into a social and cultural environment where all of the objects and events which are encountered have particular meanings within the social context" (p.2). Other researchers confirm that mastery of content area knowledge encompasses an interplay between culture, including language, and concept formation (Healy, 1990; Jegede & Okebukola, 1992; Koopmans, 1987; Olson, 1986; Olson & Torrance, 1987; Pitman, 1989; Sless, 1984; Valle, 1978; Verhoeven, 1987). Historically, many culturally diverse children have encountered school-taught science in a culturally unfamiliar manner as well as in an unfamiliar language. As a result these students never acquire the desired level of language proficiency, nor do they "understand" the science concepts taught in the classroom (Ornstein-Galicia & Penfield, 1981). Ornstein-Galicia and Penefied (1981) point out that the interplay between the child's culture and the child's way of "wrestling with knowledge" or constructing new knowledge is an issue which has been excluded from most science teacher preparation programs.

In addition to their means of constructing new knowledge, many culturally diverse learners find that their ways of thinking, knowing, and socially interacting are unacceptable in the science classroom. For example, some white teachers consider young African-American students' "stage setting behaviors" (e.g. walking in a swaggering motion to the pencil sharpener or borrowing a sheet of notebook paper from a neighbor before beginning academic work) to be rude, inappropriate, and threatening behaviors (Longstreet, 1978). Some teachers view the "wearing of colors" (e.g. wearing Raiders, Sox, and Kings baseball style caps, using red bandanas as "rags" or hats, "bagging" chino trousers and wearing black clothing - especially Starter brand jackets) as, at least, socially unacceptable behaviors, or, at worse, gang-related activities. But such "wearing of colors" are routine in the "hoods" and *barrios* of west coast inner-city communities. Thus, the student's dilemma is that social interaction rules and learning patterns acquired at home and in the child's community become an impediment as the student struggles to make sense of school learning and school ways of doing things.

Other studies, which include student populations of Asian and Native American descent concur with conclusions reached by Longstreet (1978), and Ornstein-Galicia and Penfield (1981). For example, in a study of the Hmong students learning patterns, Hvitfeldt (1986) found that cultural variables influenced verbal interaction patterns in the classroom, students' preferred learning modes, and students' concept acquisition. Studies with Hawaiian-American (Au, 1980; Au & Jordan, 1977; Spring, 1950; Weisner, Gallimore & Jordan, 1988), Asian-American (Cheng, 1992), African-American (Stewart & Benson, 1988) and Native-American (Harris, 1985; Rhodes, 1988) children indicate that the students' cultures influence the ways in which they interact with teachers and the way(s) they construct knowledge in the classroom. Moreover, as children grow into adults, their ways of interacting and constructing knowledge become ingrained into the fabric of their personalities.

Needs of Preservice Science Teachers

In summarizing research on teacher education efforts in California (the state with the largest population of culturally diverse learners in the nation), LoPresti (1985) points out that five components are common to preservice teacher education programs that successfully address the needs of teachers in multicultural classrooms. These components include: (a) a broad general education, (b) subject matter competency, (c) an awareness of the needs of culturally diverse children, (d) content area pedagogical knowledge, and (e) field experience in working with culturally diverse learners. Most colleges and universities in this nation adequately address the broad general education and content area

knowledge components (i.e., science) of LoPresti's model. However, most colleges and universities do not provide the multicultural awareness, content area pedagogical knowledge, and field experience components necessary to prepare preservice science teachers for success in multicultural science classrooms and the ones that LoPresti identified as being essential in preparing teachers to work in culturally diverse settings.

Multicultural Awareness

While traditional ethnic studies courses focus on holidays, customs, and beliefs of culturally diverse learners; a multicultural education course focuses on assisting teachers to change social practices so that their classrooms are conducive to the needs of all learners in a democratic society (Suzuki, 1984). Sleeter and Grant (1987) write that multicultural education is a multidisciplinary educational approach that seeks to assist students in gaining a better understanding of the causes of oppression and inequality in American society and a knowledge of ways in which these social problems might be eliminated. In a controlled study comparing a multicultural education approach with a traditional ethnic studies approach to developing cultural awareness, Dunbar (1980) found that a multicultural education approach improves a participants' ability to clarify their own attitudes and perceptions toward other ethnic groups (other than the one to which they belong). While investigating ways of restructuring preservice teacher preparation programs, Bennett (1979) found that a multicultural education approach accomplishes these four goals: (a) alters preservice teachers' attitudes towards other racial and cultural groups, (b) provides preservice teachers with an increased sense of self-efficacy about their abilities to work with inner-city children, (c) provides participants with an increased knowledge base regarding racial and cultural groups in American society, and (d) results in an increased awareness of the preservice teachers' own ethnic heritage. The incorporation of a multicultural education courses into preservice teacher education programs has been shown to be an effective means for preparing preservice teachers to work in multicultural classrooms and an effective means with which to address the educational, social, linguistic, and psychological needs of culturally diverse learners (Gay, 1983; Grant, 1981; Payne, 1980; Sims, 1983).

Field Experiences

Mahan and Lacefield (1982) investigated field experience in working with culturally diverse learners. In a controlled study, these researchers compared 655 preservice teachers whose student population was primarily of European descent with 2,178 preservice teachers who taught in multicultural classrooms. Mahan and Lacefield found that a field experience in culturally diverse neighborhoods: (a) increased the likelihood of employment of preservice teachers, (b) increased preservice teachers' efficacy in working with culturally diverse students, and (c) facilitates the acceptance of Anglo teachers in culturally diverse neighborhoods.

In their study of the effectiveness of a field experiences in culturally diverse schools, Cooper and Morey (1989) found that such a field experience under the supervision of a master teacher and/or resource teacher increases the retention rate of preservice teachers in culturally diverse school districts. Likewise, studies conducted at Ball State University (Payne, 1980), Texas A& M University (Mangan, 1991), Indiana University Northwest (Woerner, 1992), Indiana University-Bloomington (Mahan & Lacefield, 1982), and Stanford University (Cohen & Lotan, 1990) indicate that supervised field experiences in culturally diverse neighborhoods increase the chances that teachers will experience success in teaching culturally diverse learners.

Content Area Pedagogical Knowledge

In concert with LoPresti's position that content area pedagogical knowledge should be structured to address the educational needs of culturally diverse learners, Gay (1983) wrote that "preservice professional preparations should include knowledge about ethnic and cultural diversity, the creation and selection of instructional materials which reflect ethnic and cultural pluralism, and the translation of that knowledge into multiculturalized lesson plans and strategies for instruction" (p. 82). While many writers have echoed Gay's viewpoints, few have provided specific frameworks or instructional strategies for modifying existing "methods" courses so that they address the needs of preservice teachers preparing to work in multicultural classrooms. Cohen and her associates at the Center for Complex Instruction at Stanford University provide some of the first empirical evidence that teacher education courses can be modified to accommodate the needs of science teachers in multicultural classrooms, along with the education needs (e.g., linguistic social, emotional, and science

concept knowledge) of culturally diverse learners in those classrooms. (Readers who want to read the studies conducted by Cohen and her assoicates are referred to the following sources: Cohen, 1991; Cohen, DeAvila, Navarette & Lotan, 1988; Cohen, Intili & Robbins, 1979; Cohen & Lotan, 1990; Cohen & Lotan, 1991; Cohen, Lotan & Catanzarite, 1990; Cohen, Lotan & Leechor, 1989; Lotan, Swanson & LeTendre, 1991).

Pilot studies (Philipp, Armstrong & Bezuk, 1992; Philipp, Flores & Sowder, 1992) conducted at San Diego State University into the effectiveness of a "multicultural infusion" approach to preservice teacher preparation indicate that such an approach is not only highly feasible, but is also highly effective in producing teachers who are capable of meeting the educational needs of culturally diverse students. Philipp, Armstrong, and Bezuk (1992) point out that preservice teachers working in multicultural classrooms can be coached and mentored to incorporate knowledge gained in methods courses into daily classroom practice. Preservice teachers coached to consider the needs of culturally diverse learners consider "individual students when making curricular decisions" (p. 29). From a year long, in-depth study of a preservice teacher's student teaching and coursework experiences in a teacher credentialing program, these authors learned that this preservice teacher readily incorporated pedagogical content knowledge into her teaching practices. These authors point out that pedagogical content knowledge focusing on research-based instructional strategies appropriate for culturally diverse students is readily accepted by preservice teachers since, "unlike inservice teachers, they don't have anything to overcome" (p.29). From a study of inservice teachers in multicultural classrooms this same research group (Philipp, Flores, Sowder, & Schappelle, 1992) learned that incorporating a knowledge of individual learners and instructional strategies appropriate for these students into teacher inservice programs produces reflective practitioners, i.e. teachers who understand the milieu of the school and the community and how these are interrelated (p.35).

Multicultural Infusion in Science Teacher Education

In the past, many teacher educators, including science educators, have tended to view the needs of culturally diverse learners as being a problem of those involved in bilingual education, or inner city schools, rather than as a mainstream science education concern (Gilbert & Gay, 1985). Research discussed in this paper indicates that multicultural infusion, e.g., the conscious inclusion of instructional strategies, values, attitudes and methods to address needs of culturally diverse learners into existing teacher preparation courses, is the most appropriate means for accommodating the needs of preservice science teachers. Multicultural infusion is the conscious and consistent inclusion of a consideration of the needs of culturally diverse learners into all areas of science teacher preparation. Recommendations for infusing multicultural education are made in five areas: (a) changes in the way that we view learners and teachers; (b) inclusion of instructional strategies appropriate for culturally diverse learners; (c) modifying science content so that it is relevant to the lives of diverse learners; (d) integration of language acquisition strategies into existing science methods courses; and (e) attention to the social and cultural needs of culturally diverse learners.

Teaching and Learning

Historically, science, and so science teaching and learning, and science teacher education programs, have been predicated on foundations of objectivism. This belief system includes the notion that the teacher is the authority figure, the one who dispenses knowledge to children. Models of teaching and learning derived from this philosophical orientation in many cases are not appropriate for use with culturally diverse learners. Indeed, research previously discussed in this paper indicates that highly authoritative, teacher-directed learning models are probably inappropriate for most culturally diverse learners. Thus, it is recommended that constructivist theories of learning be used as a psychological foundation for teacher education courses for those preparing for careers in culturally diverse neighborhoods.

McDowell (1990) pointed out that "teachers' ability to foster children's understanding in science is partially dependent on their understanding of the mental models from which children operate" (p. 275). From a constructivist viewpoint, conceptual knowledge of science is constructed: (a) gradually over time, (b) by the learners within a social context, (c) through a series of interactions with the content, (d) when new information is integrated with old information, and (e) so that the result is an awareness of what is being learned (Roehler & Duffy, 1989, p. 116). In contrast with proponents of objectivism, constructivists hold that knowledge is constructed, not transmitted. Moreover,

"learning occurs within a social context as students share their ideas with peers, both in small groups and within the total society of the classroom" (Wheatley, 1991, p. 12). From a multicultural infusion perspective, then, schools rather than students, are seen as being "at risk" especially when they do not capitalize upon the richness of experience that culturally diverse learners bring to classroom social interactions. While many science teacher educators have moved to and now advocate a constructivist viewpoint, these same educators apparently have not consciously made the connection between their constructivist worldview and the needs of culturally diverse learners. Consideration of the socio-cultural context of learning has rarely been defined by constructivists as including a consideration of the child's personal culture within the "culture of the classroom".

Instructional Strategies

Since multicultural infusion mandates that consideration of culturally diverse learners' needs permeate all science education instructional activities, science teacher educators should help preservice teachers' making connections between the qualities of instructional strategies and the needs of culturally diverse learners. Instructional strategies appropriate for use with culturally diverse learners are those which include the elements of: tasks (i.e., questions or problems which have not been previously encountered by the learner), groups, and sharing (Wheatley, 1991). Specifically, inquiry-based instructional strategies which incorporate group or cooperative learning activities and provide students multiple means of representing their knowledge are effective instructional strategies for culturally diverse learners. Research (Cobern, 1991; Driver & Bell, 1986; Driver & Oldham, 1986, Roth, 1991, & Wheatley, 1991) suggests that instructional models which use problem-solving thematic approaches to learning are highly effective for culturally diverse learners because they: (a) provide multiple means of data representation, (b) allow for peer tutoring, (c) provide for the use of home language in small groups, (d) allow students to bring culturally familiar examples and elaborations into the classroom, (e) permit students to interact with manipulative materials, (f) encourage students to work cooperatively in constructing new knowledge, and (g) "fit" with what is known of the teaching/learning process from research in cognitive psychology.

The learning cycle is one instructional strategy which is appropriate for culturally diverse learners because it promotes problem solving or inquiry learning, and can include cooperative group work, peer tutoring, and the sharing of findings with others in the class (Bowers, 1991). In addition, the learning cycle provides a setting for learners to discuss science concepts with each other in their "home language" or native language. The use of manipulative materials as part of most learning cycle activities accomodates culturally diverse students' needs for multiple modes of knowledge representation. Additionally, learning cycle methodology encourages students to draw examples of scientific concepts from the context of their own interests and lives. The learning cycle and related instructional activities are recommended for use with culturally diverse learners since they fulfill Wheatley's criterion for effective instructional strategies.

Closer examination of the learning cycle reveals additional benefits for culturally diverse students. This inquiry-based or problem-solving approach focuses on open-ended questions, which allow all students to bring their "home learning" into the classroom and to generate multiple solution paths. Some of the multiple solutions may be derived from the students' previous experience in their home communities. In addition, Vygotsky (1962) pointed out that children can, in groups, perform that which they can not do by themselves. Finally, learning cycle activities allow students multiple means of presenting their new learning to others in such ways as: oral reporting, concept mapping or word webbing, journal entries, portfolios, drawings, diagrams, graphs, poems, rap songs, and other methods that might be suggested by the student or encouraged by the teacher.

It should be noted that whenever multiple means of presenting knowledge and of sharing learning experiences are incorporated into instructional activities, the linguistic needs of culturally diverse learners are more readily addressed. Instructional strategies which allow the student to build linguistic and conceptual bridges between "home learning" and "school learning" are crucial in the multicultural science classroom. Aside from the learning cycle, other instructional strategies that allow "bridge building" behaviors to occur in the classroom include: (a) interactive reading activities conducted in small heterogeneous groups (e.g. ITM - Inductive Teaching Methods, QUEST - QUEstions that Stimulate Thinking, TRICA - Teaching Reading in the Content Area techniques), (b) hands-on, inquiry based activities, (c) large group mediated conversations, (d) visually enhanced expository

teaching techniques, (e) scaffolding techniques (such as that incorporated in The Popcorn Book), and (f) small group negotiated conversations.

Relevant Curriculum

The California State Board of Education (1990) wrote "the standards of success must be equivalent for all students so that a common metric is understood and appreciated by all students" (p. 169). Application of this state board of education guideline and other comparable guidelines directs that multicultural infusion in science does not mean "lowering the standards". Rather, the guiding principle and end result would be to make the standards accessible to all students. A cursory examination of science textbooks, videos, movies, filmstrips, and computer tutorials reveals that they lack culturally diverse representations of people, and examples of objects and experiences familiar to a culturally diverse population. For example, textbooks and resource materials used in science classrooms frequently incorporate analogies, metaphors, and elaborations based on the rural American farm experience. Such materials may include stories of chickens hatching eggs, of cows giving birth, or of corn growing in the fields. These particular elaborations may be commonly known to mainstream rural and suburban youth, but they are unfamiliar to many inner-city students. Likewise, the mention of a fuse box or a circuit breaker in a physics textbook is a referent unknown to children living in high-rise apartment buildings. References to oaks, poison ivy, and Staghorn sumac commonly found decidious hardwood forests may be appropriate for students living in the Northeast quadrant of the United States, but these examples hold little meaning for Mexican-American students in the Southwest quadrant who are accoustomed to seeing gramma grass, prickley pear cacti, and Joshua trees.

Additionally, teachers should incorporate culturally familiar elaborations and content in order to enhance culturally diverse students' science concept acquisition (Cohen, DeAvila, Navarette & Lotan, 1988; Cohen, Intili & Robbins, 1979; Cohen & Lotan, 1991; Lotan, Swanson & LeTendre, 1991). It is recommended that preservice teachers be coached in personalizing the curriculum by including examples from students' own lives as a part of everyday classroom instruction. Additionally, preservice teachers should be encouraged to include culturally diverse role models (e.g. culturally diverse men and women of science) in their instruction. The point to be made here is that attending to the needs of culturally diverse learners means that preservice science teachers need to be encouraged to include culturally familiar examples in their instruction.

Language Acquisition Skills

It has been previously noted in this paper that culturally diverse learners frequently speak a "home language" or native language different from mainstream America. Recent studies (Mason & Barba, 1992; Barba & Mason, in press) indicate that Limited English Proficient (LEP) students are frequently mainstreamed into regular science classrooms without proper linguistic support services. In addition, regular science classroom teachers are sometimes expected to teach science to large numbers of LEP students without a knowledge of language acquisition skills. As a result, teachers feel frustrated and students do not master science concepts or acquire proficiency in the use of the English language. Monolingual English speaking teachers may address the needs of Limited English Proficient students through the use of sound teaching practices, including: "(a) simplifying the input, (b) providing context clues, (c) drawing on students prior background, (d) working to ensure understanding, (e) making sure that instruction is content-driven, (f) ensuring that instruction is student centered, and (g) using science textbooks effectively" (California Department of Education, 1990, pp. 170- 171). In addition to implementing such sound teaching practices, it is recommended from the research (Cummins & Swain, 1986; San Diego City Schools, 1982) that language acquisition skills be infused into the regular science teacher instructional program in order to address the linguistic needs of bilingual students. Therefore, language acquisition skills and discussion of the need for these skills ought to be incorporated into science methods courses.

The daily use of language acquisition strategies in the classroom should lead science teachers to "make attempts to restate, redefine, provide culturally familiar examples, and draw on students' prior backgrounds when teaching science concepts" (California Department of Education, 1990, p. 170). Students who are not fully assimilated in the use of the English language rely on multiple means of knowledge representation (i.e. *realia*, oral words, written words, pictures, and icons) when attempting to construct a personal rendition of knowledge. Culturally familiar examples, analogies, and metaphors benefit Limited English Proficient students. It is recommended that preservice teachers should be

mentored in the use of questioning skills in their science methods courses, questions that provide insights into the way(s) that children have constructed knowledge. Preservice teachers need to be encouraged to use peer tutoring in the child's native language. Finally, when textbooks are used as an instructional medium, preservice teachers should be encouraged to use interactive, cooperative reading strategies such as the three-tiered study guide technique advocated by Herber (1978). Since many science methods courses contain elements of language acquisition, a study of these strategies and their primacy as tools for instructing culturally diverse students should be deliberately infused into existing preservice science education experiences.

Social and Cultural Awareness

King (1991) asserts that "prospective teachers need both an intellectual understanding of schooling and inequity as well as self-reflection or transformative emotional growth experiences" (p. 134). Earlier in this paper it was pointed out that stereotyping culturally diverse children is a dangerous and insensitive practice. Therefore, all preservice science teachers need to develop an awareness and a sensitivity to the cultural, linguistic, and social variables in the lives of their students. One could argue that a knowledge of students and the communities in which they were reared are "basic skills" for all science teachers, especially for teachers in the multicultural classroom. A poignant example is that science teachers who instruct Vietnamese students in Southern California have a very different classroom environment and experience than do their peers who teach bidialectic students in inner-city schools in the Eastern United States. The language, culture, social values, and ethnic histories of students should influence the way(s) that information is presented to students, the examples that teachers use, and the instructional strategies that teachers select as being appropriate.

Figure 1.
"Restructured" Science Methods Course to
Accomodate Culturally Diverse Learners

Science Methods Course Topic	Multicultural Infusion Opportunity
Goals of science teaching	Equity issues for culturally diverse learners
Scientific methods	Culturally diverse men and women of science
Learning theory	Impact of culture on learning
Teaching strategies	Learning styles of culturally diverse learners
Science laboratory	Multiple modes of knowledge representation
Extramural science activities	Parental and community involvement in science education
Science/technology/society	Real world and community applications of science
Reading in the science classroom	Language acquisition skills and friendly textbooks
Technology in the science classroom	Training diverse learners for the "real world"
Classroom management	Knowledge of diverse learners ways of interacting
Planning	Accommodation of diverse learners "learning" styles
Testing and evaluation	Alternative and authentic assessment
Science processes	Multiple modes of knowledge representation
Science attitudes	Underrepresentation of diverse learners in science careers

In preparing preservice science teachers for positions in multicultural classrooms, science educators ought to infuse an awareness of cultural diversity and the needs of culturally diverse learners in all areas of instruction. Again, it should be noted that multicultural infusion in science teacher prepartion is differentiated from the "traditional" ethnic studies approach in that the goal of multicultural infusion is to develop an awareness of the educational needs of minority students in every science teacher and to translate that awareness into appropriate instruction for all children. Multicultural infusion produces "ethnically literate" science teachers who are capable of providing culturally affirming science instruction.

Conclusion

Consideration of the socio-cultural context of learning includes an awareness of the educational needs of culturally diverse learners. Multicultural infusion offers the opportunity for science teacher educators to prepare a new generation of science teachers who are capable of meeting the needs of culturally diverse learners. Research shows that effective preservice science teacher education programs need to include a broad educational background, a knowledge of science, field experiences in culturally diverse neighborhoods, multicultural studies, and relevant science education courses which provide content area pedagogical knowledge for future teachers in multicultural classrooms.

Existing science methods courses and indeed all education courses ought to be modified to address the needs of future teachers in multicultural classrooms by: (a) the use of a constructivist approach to teaching and learning, (b) the incorporation of instructional strategies appropriate for culturally diverse learners, (c) the inclusion of relevant course content, (d) the introduction of language acquisition skills as part of teacher preparation, and (e) a focus on the social and cultural characteristics of diverse learners. Multicultural infusion (e.g. the inclusion of a consideration for the needs of culturally diverse learners into all aspects of science teacher preparation) produces culturally and ethnically literate teachers who are able to meet the needs of culturally diverse learners. Multicultural infusion is a process, not a product, its aim being to produce culturally affirming classrooms which address the science education needs of an increasingly pluralistic society.

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